Space Weather Technical Forecast

Issued on Sunday, 16 January 2022 at 00:33 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1/Minor Storm intervals Day 1 (16 Jan). Chance of M-class flares (R1/R2 radio blackouts) throughout. Active fluence likely by Day 4 (19 Jan).

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Low with several C-Class flares over the past 24 hours, the largest a C4 flare at 15/0854 UTC from AR2932, at the NE limb. There are currently 8 sunspot regions on the visible disc, of which AR2932 as already mentioned is the most active at present. AR2929, AR2930 and AR2931, all in the northwest quadrant, have the most complexity but no significant flare activity. The remaining sunspot groups are relatively small and simple. No Earth-directed coronal mass ejections (CMEs) have been observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds as observed by DSCOVR at L1 showed a transition into the main part of the HSS associated with CH44/-. Wind speeds started at slightly elevated levels, before increasing after 15/1400 UTC to reach elevated levels near 600 km/s by the end of the period. Density was above average, peaking at 20 ppcc, before falling to below average levels from 15/2100 UTC. Total IMF strength, Bt, was at weak to moderate levels, peaking at 13 nT around 15/1500 UTC. The Bz component varied moderately between +11/-12 nT. Phi angle was predominantly negative (towards the Sun). Geomagnetic activity was Quiet to Active, with a G1 interval 15/2100-0000 UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) remained at Background levels throughout, although a brief very slight enhancement was observed just after 15/0000 UTC. High energy electron flux (greater than 2MeV) was at background levels, temporarily reaching moderate levels of 166 pfu at 15/2000 UTC. Electron fluence remained well below the Active threshold (1e8 integrated pfu) on a steady trend, with 1.81e6 integrated pfu recorded at 16/0000 UTC.

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to be Low to Moderate, with further C-class flares expected and a chance of M-class flares. Another two regions are expected to rotate on from the far side within the next two days, and this could also increase solar activity.

Solar Wind / Geomagnetic Activity: No Earth-directed CMEs are currently expected, although one CME is expected to pass close to Earth on Day 1 or possibly on Day 2 (16-17 Jan). The solar wind is expected to be elevated to strong through Day 1, starting to decline from Day 2 onwards. Occasionally Unsettled to Active periods are likely on Day 1, with isolated G1/Minor Storm intervals still possible, and then to a lesser extent through Sunday night into Day 2 due to possible weak CME influences. Geomagnetic activity is then expected to decline to Quiet to Unsettled levels during Day 2.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is forecast to remain at predominantly background levels. The high energy electron flux (greater than 2MeV) may start to rise through this period. The associated 24-hour electron fluence is

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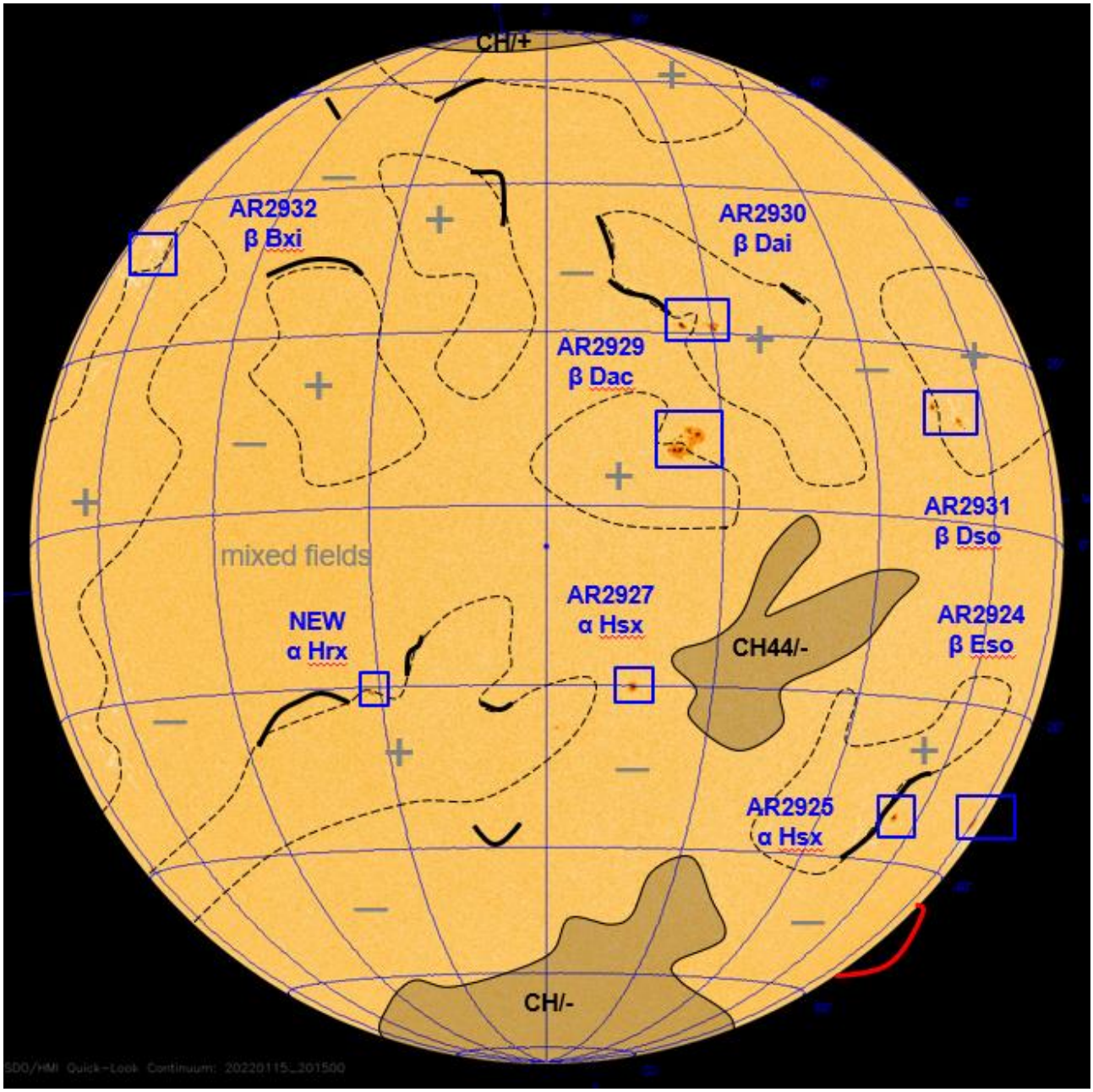
likely to increase, although the timing and extent of this is low confidence. Fluence may reach Active levels by the end of the period.

Figure 1. Solar Analysis Valid 15/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

No Earth-directed CMEs are currently expected, although the CME associated with a filament lift-off on the afternoon UTC of the 14th, in the southwest quadrant near AR2925, is expected to pass close to Earth on Day 1 or perhaps early on Day 2 (16-17 Jan). This was a southward directed CME so the bulk of the ejecta is expected to pass below Earth. Confidence is low regarding this CME, but there is a slight chance of weak CME influences at Earth, although these are likely to be mixed with the effects of the HSS.

The solar wind speed is expected to continue at elevated to strong levels through today, with speeds 550-650 km/s. The HSS influence is then expected to gradually decline back to ambient levels from Day 2 onwards.

Occasionally Unsettled to Active periods are likely on Day 1, with isolated G1/Minor Storm intervals still possible, and then to a lesser extent through Sunday night into Day 2 due to possible weak CME influences. Geomagnetic activity is then expected to decline to Quiet to Unsettled levels during Day 2.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	40	10	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
*	*	*	*	*	*	*

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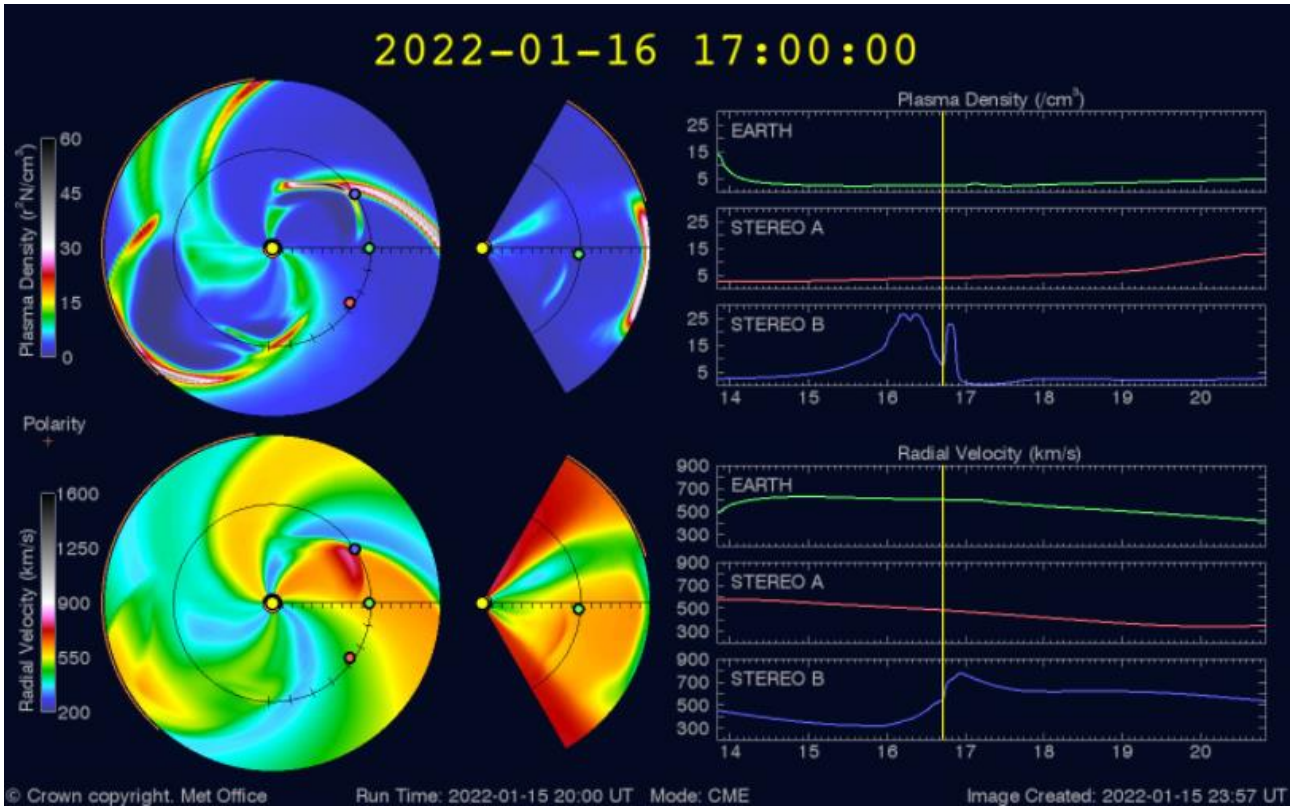
Figure 2: MOSWOC Enlil model showing a CME passing just ahead of Earth later on Day 1 (16 Jan).



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Radio Blackouts - X-Ray Flares:

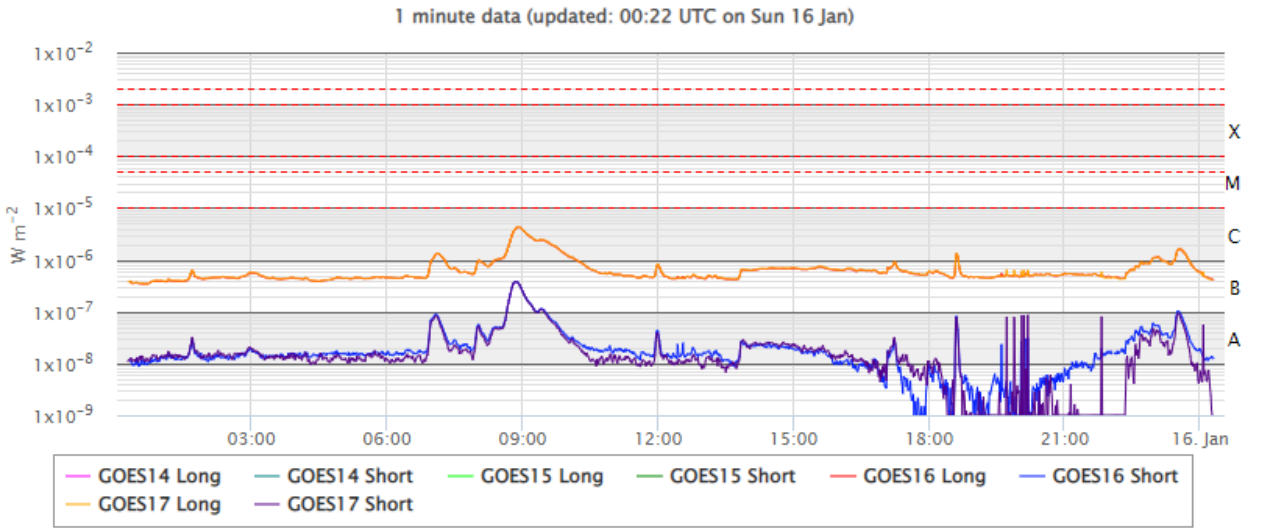
Solar activity has been Low with several C-Class flares over the past 24 hours, the largest a C4 flare at 15/0854 UTC this morning from AR2932, at the NE limb. There are now 8 sunspot regions currently on the visible disc.

AR2930 has seen its growth ease somewhat through this period, and is now classified Dai/Beta. AR2929 has also seen its growth trend ease, perhaps with some very weak Delta configuration, although for now remains classified as Dac/Beta. AR2931 has simplified very slightly, now classified Dso/Beta. AR2932 has rotated further onto the visible disc and appears fairly simple at the present time, classified Bxi/Beta, although it was the source of the C4 flare. The other numbered regions are small and simple. A new region is developing in the southeast quadrant, currently classified Hrx/Alpha.

Two further far-side sunspot regions (ex-2916 and 2918) are also likely to rotate onto the disc on Days 1 and 2 (16-17 Jan). This brings a slightly increased chance of M-class flares, and probabilities have been increased during the period to reflect this.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	40	40	40
Very Active	R3 to R5 X Class	No	2	5	5	5

Figure 3: X-ray trace of last 24 hours, showing only C-class flares, mainly from AR2932.



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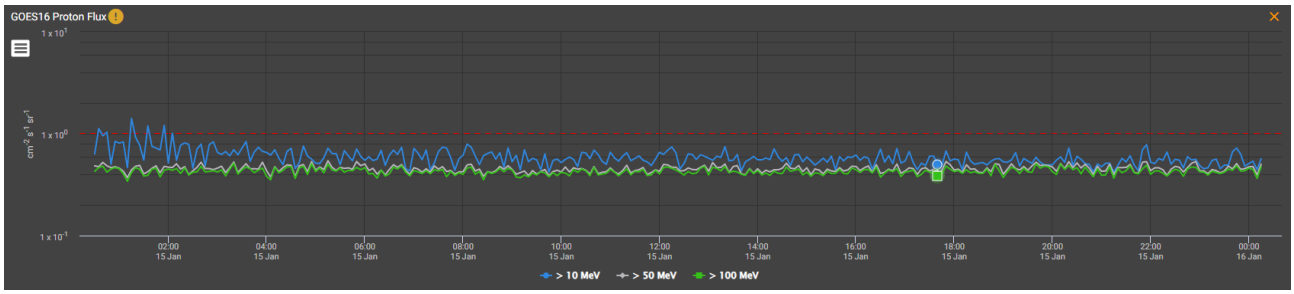
Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) as observed by GOES-16 has returned to background levels after a brief very slight enhancement around midnight UTC. Background levels are forecast to continue barring any significant flares or new Earth directed CMEs in the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	2	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: Brief proton response last night, likely due to the flare which produced the CME expected to pass close to Earth later today.



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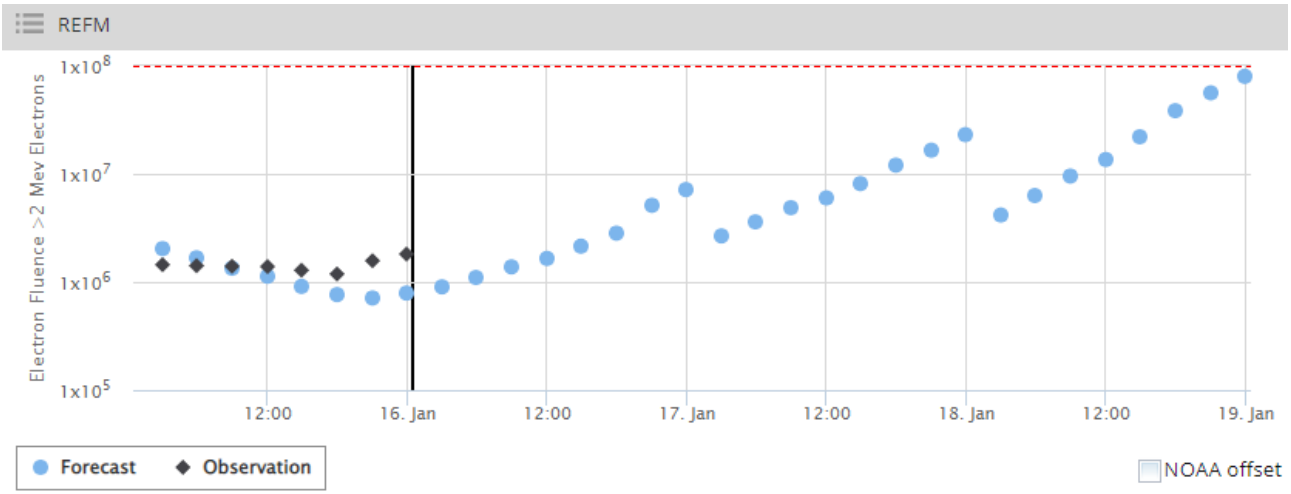
High Energy Electrons Event (≥ 2MeV):
The high energy electron flux (greater than 2MeV) as observed by GOES-16 has been predominantly at background levels. Flux levels are likely to rise when the radiation belts de-compress as the HSS of CH44 wanes. This feature on the previous rotation did give an electron response with flux reaching High levels. However, the possibility of a glancing blow from a CME most likely on Day 1 (16 Jan), may cause an initial suppression in electron levels which means the forecast is low confidence.

The associated 24-hour electron fluence will start below the Active (1e8 integrated pfu) threshold at first, with the possibility of an increase during this period, and may reach Active levels by Day 4 (19 Jan).

The Met Office REFM output is currently giving reasonable guidance, showing an increasing trend in the fluence levels, although below Active by the end of Day 3 (18 Jan).

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	5	20	40	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 5: REFM model showing an increasing trend in the fluence levels, perhaps reaching Active on Day 4 (19 Jan).



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